

ES&H manual

Environment, Safety, and Health

Volume II

Part 22: Emergencies, Earthquakes, Fire

22.3

Response Plan for Fire in an Explosives Area

(Formerly H&SM S24.30)

Recommended for approval by the ES&H Working Group

Approved by: Robert W. Kuckuck
Deputy Director for Operations

New document or new requirements

Approval date: March 3, 2000

Editorial update: April 1, 2001

DISCLAIMER

This document was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor the University of California nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or the University of California, and shall not be used for advertising or product endorsement purposes.

This work performed under the auspices of the U.S. Department of Energy by University of California Lawrence Livermore National Laboratory under Contract W-7405-ENG-48.

22.3

Response Plan for Fire in an Explosives Area***Contents**

1.0 Introduction	1
2.0 Hazards.....	1
3.0 Controls	1
3.1 Explosive Hazard Classifications and Fire Divisions	1
3.1.1 Explosive Hazard Classifications.....	1
3.1.2 Fire Divisions.....	2
3.2 Placarding with Fire Division Symbols	2
3.3 Emergency Response Plans	3
3.3.1 Setback Distances	3
3.3.2 Emergency Withdrawal Distances	5
3.4 Emergency Response Procedures.....	6
3.4.1 Initial Actions.....	6
3.4.2 Cooling-off Period.....	6
3.4.3 Re-entry	6
4.0 Responsibilities.....	7
4.1 Hazards Control Department.....	8
4.1.1 Fire Department	8
4.1.2 ES&H Teams	8
4.2 Facility/Program Personnel	8
5.0 Work Standards.....	8
6.0 Resources for More Information.....	9
6.1 LLNL Contacts.....	9
6.2 Applicable Lessons Learned.....	9
6.3 Other Sources.....	9

Appendices

Appendix A Explosives Hazard Warning Placards (Fire Division Symbols).....	10
Appendix B Class/Division Definitions	12

* Minor revision

Tables

Table 1.	Placard shapes, explosive hazard classification, and hazards for fire divisions	3
Table 2.	Minimum setback distances based on DoD 6055.9-STD	4
Table 3.	Minimum emergency withdrawal distances based on DoD 6055.9-STD	5

22.3

Response Plan for Fire in an Explosives Area

1.0 Introduction

This document describes the placarding requirements for facilities containing explosives and procedures for fire fighters responding to fires in explosives areas. The primary objective of these procedures is to provide protective measures to minimize injury.

This document applies to all operations at the Livermore site and Site 300 involving explosives and to individuals who perform such operations.

2.0 Hazards

The major hazard from explosives is personal injury or property damage caused by heat, blast, noise, fumes, and flying debris or projectiles from unintentional or inadequately controlled ignition or explosion of such materials. Injuries ranging from minor to fatal could include trauma, lacerations, eye injury, hearing impairment, and burns. Property damage could range from minor to major. Energetic materials are especially vulnerable to elevated temperature, which would be expected for materials exposed to a fire. Possible consequences could range from mild decomposition to vigorous deflagration or detonation.

3.0 Controls

This section describes procedures for responding to fires in explosives areas and the hazard classification for each fire division. Signs and symbols associated with each fire division are shown in Appendix A.

3.1 Explosive Hazard Classifications and Fire Divisions

3.1.1 Explosive Hazard Classifications

Every operation at LLNL and Site 300 involving explosives is conducted under the provisions of a safety plan. Each safety plan includes a hazard analysis of the operation and classification of the hazard. The type of explosives present roughly determines the hazard classification.

LLNL uses the United Nations Organization (UNO) hazard classification system for classifying explosive materials and explosive components. The UNO system is

recognized internationally and has been used by the Department of Defense (DoD) and other Department of Energy (DOE) contractors for many years. The Department of Transportation (DOT) has also converted to this system.

The UNO system consists of nine classes of dangerous goods, with explosives making up Class 1. The explosives hazard class is further subdivided into six divisions, which are used for segregating ammunition and explosives on the basis of similarity of characteristics, properties, and accidental effects potential. Hazard severities are classified as

- Class/Division 1.1 (mass explosion)
- Class/Division 1.2 (nonmass explosion, fragment producing)
- Class/Division 1.3 (mass fire, minor blast, or fragment)
- Class/Division 1.4 (moderate fire, no blast)
- Class/Division 1.5 (very insensitive explosives/blasting agents)
- Class/Division 1.6 (extremely insensitive ammunition)

Appendix B gives a detailed description of each hazard class/division.

3.1.2 Fire Divisions

Fire Divisions 1–6 are synonymous with Class/Divisions 1.1–1.4, as described in the *DOE Explosives Safety Manual*. Fire Division 1 indicates the greatest hazard. The hazard decreases as the fire division numbers increase. Because the fire-fighting hazards are similar, Fire Division 1 and 2 fire symbols and numbers are also used for Class/Divisions 1.5 and 1.6, respectively.

3.2 Placarding with Fire Division Symbols

Chapter II, Section 22.1, of the *DOE Explosives Safety Manual* states that facilities and areas containing explosives must have placards that warn individuals of potential hazards from explosives, and those placards must provide information about dealing with emergencies.

Facilities containing explosives at the Livermore site and Site 300 are placarded with distinctive fire division symbols (shown in Appendix A) to warn emergency response personnel of potential hazards. These symbols enable fire fighters to quickly recognize the potential hazards of explosives they are approaching. The placard's shape, hazard, and class/division of explosives given in Table 1 are based on the classification system in DoD 6055.9 STD.

Table 1. Placard shapes, explosive hazard classification, and hazards for fire divisions.

Fire division	Placard shape (symbol)	Hazard class/division	Hazard
1	Octagon (1)	1.1, 1.5	Mass explosion
2	Cross (2)	1.2, 1.6	Nonmass explosion, fragment producing
3	Inverted triangle (3)	1.3	Mass fire, minor blast, or fragment
4	Diamond (4)	1.4	Moderate fire, no blast

The fire division symbol that applies to the most hazardous material present shall be posted on or near all buildings and areas containing explosives. For additional precaution, half-sized symbols may be used for interior rooms, magazines, laboratories, and lockers and safes. Exterior fire division symbols must be visible from all approaching roads. One fire division symbol posted on or near the door of an igloo-type magazine is normally adequate. Multiple magazines or cubicles should each have a fire division symbol with a separate full-sized symbol posted to reflect the overall hazard.

3.3 Emergency Response Plans

Emergency Response Plans ("run cards") contain relevant information on all hazards in a facility and specify the explosive hazard, setback and emergency withdrawal distances, and response procedures. The LLNL Fire Department shall be responsible for preparing Emergency Response Plans for explosives facilities at the Livermore site and Site 300.

Whenever any safety plan changes the status of an Emergency Response Plan, the area Environment, Safety, and Health (ES&H) Team shall notify the emergency dispatcher at Fire Station I for Livermore facilities and Fire Station II for Site 300 facilities. This notification must be made verbally at the time of the change and must be followed by a copy of the revised safety plan.

3.3.1 Setback Distances

The setback distances specified in Table 2 are the distances personnel initially withdraw to when an accident or fire involves a facility or vehicle containing explosives and the Emergency Response Plan information is not available. These are also the minimum distances at which the command post may be initially setup. With approval of Hazards Control explosives safety personnel, facility-specific setback distances may be reduced from those specified in Table 2 when facility design and construction protective features (e.g., blow-out panels, directed blast), earth berms, and natural terrain provide the necessary protection to personnel. Greater distances may be required depending on the nature and quantity of the explosives and the incident.

Table 2. Minimum setback distances based on DoD 6055.9-STD. These distances were established to minimize exposure to blast fragments and overpressure from a detonation when facility-specific Emergency Response Plans are not available.

Facility/ equipment	Fire division			
	1	2	3	4
Livermore site				
Building 132N	50 ft (15 m)	NA	50 ft (15 m)	NA
Building 191	25 ft (8 m)	NA	25 ft (8 m)	25 ft (8 m)
Building 194	25 ft (8 m)	NA	25 ft (8 m)	25 ft (8 m)
Building 212	25 ft (8 m)	NA	25 ft (8 m)	25 ft (8 m)
Building 341	50 ft (15 m)	NA	50 ft (15 m)	50 ft (15 m)
Building 327	25 ft (8 m)	NA	25 ft (8 m)	25 ft (8 m)
All other buildings containing explosives	100 ft (30 m)	NA	100 ft (30 m)	100 ft (30 m)
All Site 300 buildings containing explosives	1250 ft (381 m)	800 ft (244 m)	300 ft (91 m)	100 ft (30 m)
DOE explosives vehicles	1250 ft (381 m)	800 ft (244 m)	300 ft (91 m)	100 ft (30 m)
Non-DOE explosives vehicles	2500 ft (762 m)	2500 ft (762 m)	600 ft (183 m)	300 ft (91 m)

NA = Not applicable.

Following are recommended fire-response actions for setback distances that are based on the class/division and location (or quantity) of the explosives. The presence of other hazardous materials or conditions may require a more conservative approach than the actions listed here.

1. Personnel must be protected from fragments at setback distances less than 2500 ft for Class/Divisions 1.1 and 1.2 explosives.
2. The maximum debris throw range, if known, with a safety factor of 2 may be used to replace the minimum distances given in Table 2 for Site 300 facilities.

3.3.2 Emergency Withdrawal Distances

The emergency withdrawal distances specified in Table 3 are the guideline distances to which nonessential personnel (as determined by the incident commander) are to withdraw if

- A fire of any size involves or is supplying heat to explosive material.
- The fire is so large that it cannot be extinguished with hand extinguishers.

Table 3. Minimum emergency withdrawal distances based on DoD 6055.9-STD. These distances were established to minimize exposure to blast fragments and overpressure from a detonation.

Facility equipment	Fire division			
	1	2	3	4
All Livermore facilities containing explosives	100 ft (30 m)	NA	100 ft (30 m)	50 ft (15 m)
All Site 300 facilities containing explosives	2500 ft (762 m)	2500 ft (762 m)	600 ft (183 m)	300 ft (91 m)
All DOE explosives vehicles	2500 ft (762 m)	2500 ft (762 m)	600 ft (183 m)	300 ft (91 m)
All non-DOE explosives vehicles	4000 ft (1220 m)	2500 ft (762 m)	600 ft (183 m)	300 ft (91 m)

The following recommended fire-response actions for emergency withdrawal distances are based on the class / division and location (or quantity) of the explosives. The presence of other hazardous materials or conditions may require a more conservative approach than the actions listed here.

1. Personnel must be protected from fragments and kept away from windows at emergency withdrawal distances less than 2500 ft for Class/Divisions 1.1 and 1.2 explosives.
2. When the facility has been evaluated and is capable of fully containing the blast and fragments produced by an accidental detonation or deflagration, the incident commander may reduce emergency withdrawal distances. The High Explosives Applications Facility (HEAF) meets this criterion.
3. Structures or protected locations offering equivalent protection for the distances listed in Table 3 may be used in lieu of relocating personnel to other structures or locations with the specified withdrawal distance.
4. The maximum debris throw range, if known, with a safety factor of 2 may be used to replace the minimum distances specified in Table 3.

3.4 Emergency Response Procedures

3.4.1 Initial Actions

Fire fighters responding to a fire in an explosives area should bring the Emergency Response Plan, which contains relevant information on all hazards in the facility. Once at the scene, the fire fighters should

- Set up a command post at the specified setback distance, taking advantage of all possible cover.
- Observe the building for visible smoke or flames, if possible.
- Obtain all pertinent information about the status of explosives material in the facility from knowledgeable facility personnel. If the class/division or the amount of explosive material involved is different than originally assumed, adjust response actions accordingly.
- Have personnel from the Protective Force Division help control the evacuation and seal off the area in accordance with the Emergency Response Plan.

Fire fighters shall not enter the facility unless instructed to do so by the incident commander.

3.4.2 Cooling-off Period

After all personnel are safe and accounted for, a cooling-off period is required before anyone can enter the facility. In general, the more uncertain the hazard, the longer this cooling-off period should be. If smoke or flames are visible, for example, allow at least one hour after the smoke or flames are no longer visible for cooling off. If the alarm occurred at night in an extremely hazardous area, it would be advisable to wait until the next morning to enter the facility.

3.4.3 Re-entry

Re-entry Team Members. The re-entry team will normally consist of two persons, one of whom should be familiar with the facility and the explosives. While this person usually will be the facility point of contact, another person (building coordinator, facility manager, or his/her designee) may be assigned by the incident commander. The other person is usually the fire captain, who is experienced in entry and rescue techniques.

Note: In the Laser Program, the facility point of contact is referred to as the building safety coordinator, and at Site 300, as the building supervisor.

Protective Equipment. The re-entry team should be equipped with head and face protection, complete sets of flame-resistant clothing, and transceivers or other means of communication. Other necessary equipment may include keys to buildings, flashlights, extinguishers, binoculars, breathing apparatus, safety shoes, booties, and fire-fighting boots. The Fire Department will provide respiratory protective equipment, as needed. The incident commander will determine at the scene what protective equipment is required.

Warning: The use of radio transmitters may cause electroexplosive devices (e.g., squibs or blasting caps that are sensitive to radio-frequency fields) to activate. If this is a possibility, do not use portable transmitters closer than 15 ft (5 m) of such devices (from the Institute of Explosives Pamphlet 20, *Radio Frequency Energy*).

Re-entry Procedure. The re-entry team must be given a briefing on all relevant facts, including the safest route for approaching the facility. The team should not approach the building from the frangible side. The Fire Department captain should cautiously approach the building while the other team member keeps him/her in constant view. The captain should first approach and read the fire alarm annunciator panel to determine which section of the building is alarmed and relay this information to the incident commander. As the lead, the captain should feel doors for heat before opening them cautiously.

During the approach, the team should look for signs of fire or heat, such as scorched places, bulging structural members, smoke, and discoloration. If any unexpected, dangerous condition is found, the team should move to a safe location and delay the re-entry. The team should relay all observations and details of the re-entry to the incident commander using a dedicated radio frequency. The incident commander will direct the next appropriate actions to protect the facility or continue the stand-off based on information received to this point.

Upon completing all actions necessary to eliminate the emergency, control of the facility will be transferred to the facility point of contact for follow-up investigation and any required reports.

4.0 Responsibilities

General responsibilities for all workers are described in Document 2.1, "Laboratory and ES&H Policies, General Worker Responsibilities, and Integrated Safety Management" in the *ES&H Manual*. Specific responsibilities for fire response in an explosives area are listed below.

4.1 Hazards Control Department

4.1.1 Fire Department

The LLNL Fire Department is responsible for

- Preparing appropriate emergency response plans for explosives facilities at the Livermore site and Site 300.
- Responding to fires with an on-scene incident commander and fire fighters.

The on-scene incident commander is in charge of the Incident Command Post and is responsible for preventing loss of life or property and reducing the impact on the environment.

4.1.2 ES&H Teams

The ES&H team is responsible for notifying the Emergency Management Division (LLNL Fire Department) for Livermore and Site 300 facilities whenever any safety plan changes the status of an Emergency Response Plan.

4.2 Facility/Program Personnel

Facility or program personnel shall

- Ensure that the appropriate fire division placard is posted on facilities and areas containing explosives.
- Follow the orders of the incident commander and Protective Force Division personnel.
- Accompany a Fire Department member on the re-entry team when requested to do so.

5.0 Work Standards

DOE M 440.1-1, "DOE Explosives Safety Manual."

6.0 Resources for More Information

6.1 LLNL Contacts

For further information about this document, contact the following as necessary:

- Emergency Management Division (LLNL Fire Department)
- ES&H Teams
- Hazards Control Safety Programs Division, explosives safety technical leader

6.2 Applicable Lessons Learned

The Lessons Learned Program is available on the Internet at the following URL address:

http://www-r.llnl.gov/es_and_h/lessons/lessons.shtml

6.3 Other Sources

DoD 6055.9 STD, "Ammunition and Explosives Safety Standards." This document specifies the setback distance, withdrawal distance principles, facility placarding guidelines, and fire symbols specified in this document.

Institute of Explosives Pamphlet 20, *Radio Frequency Energy*.

Appendix A

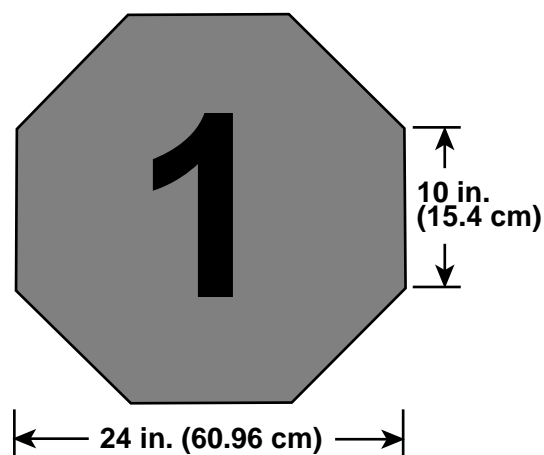
Explosives Hazard Warning Placards (Fire Division Symbols)

A.1 General

The four distinctive fire symbols shown in this appendix are based on DoD 6055.9 STD ("Ammunition and Explosives Safety Standards") and are used to alert fire fighters to the DOE Class 1 explosives hazards (Divisions 1–6). Fire Division 1 symbol indicates the greatest hazard. The hazard decreases as the fire division numbers increase. Hazard Class/Divisions 1.5 and 1.6 are not normally used at LLNL; these refer to explosion hazards from less sensitive substances and extremely insensitive articles, respectively. Fire symbols shall be posted on or near all buildings and areas containing explosives. For additional precaution, half-sized symbols may be used for interior rooms, magazines, laboratories, and lockers and safes.

A.2 Colors and Dimensions

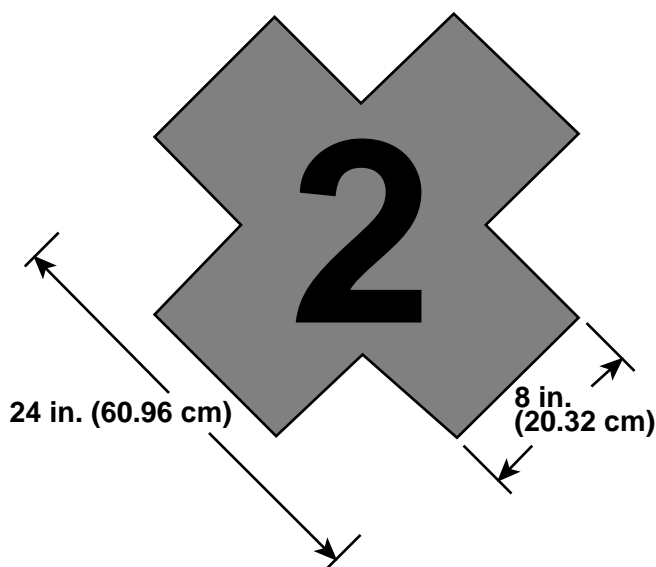
The background color of each placard is orange (#12246, Federal Standard 595A), and the numbers are black (#17038, Federal Standard 595A) and are 10 in. × 2 in. (25.4 cm × 5.08 cm).



Fire Division 1 symbol (mass explosion/
blasting agents)

24 in. (60.96 cm) (NSN-7690-01-082-6289)

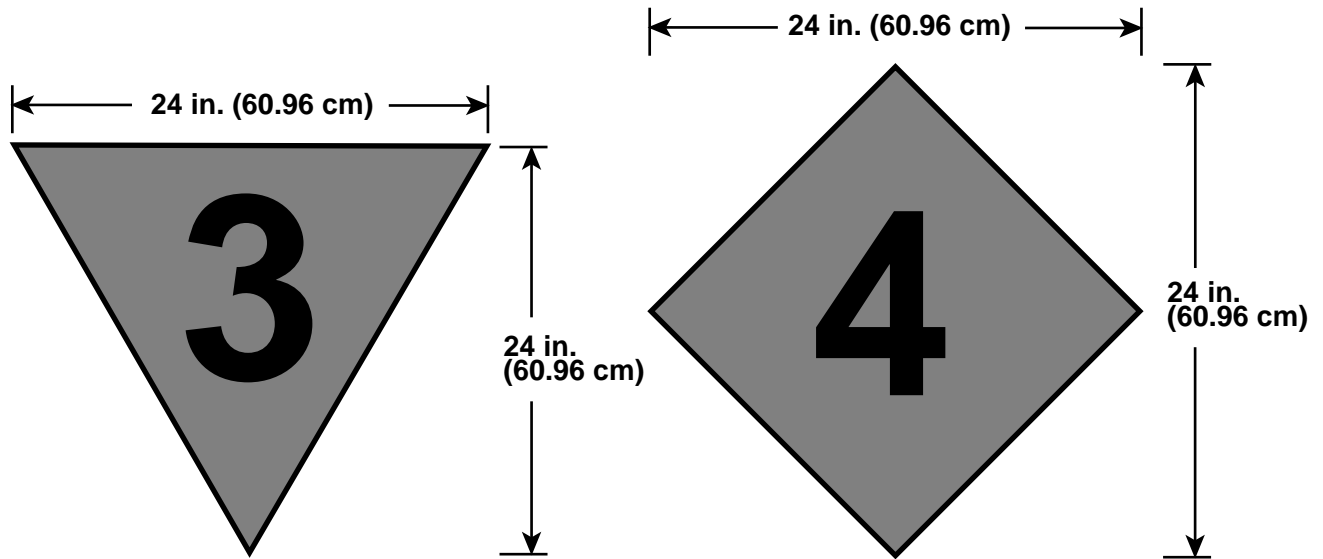
12 in. (30.48 cm) (NSN-7690-01-081-9581)



Fire Division 2 (explosion with fragment
hazard/nonmass explosion/EIDS article)

24 in. (60.96 cm) (NSN-7690-01-082-0289)

12 in. (30.48 cm) (NSN-7690-01-087-7340)



Fire Division 3 symbol (mass fire)
 24 in. (60.96 cm) (NSN-7690-081-9583)
 12 in. (30.48 cm) (NSN-7690-081-9582)

Fire Division 4 (moderate fire/no blast) symbol
 24 in. (60.96 cm) (NSN-7690-01-082-6709)
 12 in. (30.48 cm) (NSN-7690-01-081-9584)

Appendix B

Class/Division Definitions

Class/Division 1.1 (Mass Explosion). Entire quantities of items in this division can detonate almost instantaneously. Some examples include bulk explosives, some propellants, mines, bombs, demolition charges, torpedo and missile warheads, rockets, palletized projectiles loaded with TNT or Composition B, 8-in. and larger high-capacity projectiles loaded with Explosive D, mass-detonating ammunition components, blasting caps, unpackaged detonators, demolition materials, LX and PBX explosives, detasheet, black powder, smokeless powder, unpackaged squibs, nitroglycerine, candle pads, mirror pads, shape charges, and dynamite.

Class/Division 1.2 (Nonmass Explosion, Fragment Producing). Items in this division do not mass detonate when a single item or package in a stack is initiated. Explosions involving these items result in their burning and exploding progressively, a few at a time, projecting fragments, firebrands, and unexploded items from the explosion site. Blast effects are limited to the immediate vicinity, but fragments may be projected out to 1800 ft. Most fragments produced by incidents in this division will fall within one of four specified distances: 400, 800, 1200, or 1800 ft. Examples include artillery projectiles, rocket motor igniters, and some primers.

Class/Division 1.3 (Mass Fire, Minor Blast, or Fragment). Items in this division burn vigorously (deflagrate) with little or no chance of being extinguished in storage. Explosions will normally be confined to pressure ruptures of containers and will not produce propagating shock waves or damaging blast over pressure beyond the magazine distance. A severe hazard from the spread of fire may result from burning container materials, propellant, or other flaming debris tossed about by the force of the pressure ruptures. Examples include some rocket motor propellants, most gun propellants, document destroyers, flares, markers, and signal smokes.

Class/Division 1.4 (Moderate Fire, No Blast). Items in this division present a fire hazard with no blast hazard and virtually no fragmentation or toxic hazard beyond the fire clearance ordinarily specified for high-risk materials. Examples include most small arm ammunition, DOT-packaged detonators, squibs, primers, explosive bolts, and valves. Some articles such as detonators, primers, and squibs revert to Division 1.1 or 1.2 when removed from the DOT packaging.

Class/Division 1.5 (Very Insensitive Explosives/Blasting Agents). These explosive substances are also known as extremely insensitive detonating substances (EIDS) and basically are the same as the former explosives category of insensitive high explosives. This division encompasses substances that, although mass detonating, are so insensitive that the probability that burning can spread and initiate detonation in storage is

negligible. Commercial blasting agents such as ammonium nitrate fuel oil (ANFO) and ammonium nitrate emulsions also fall in this division.

Class/Division 1.6 (Extremely Insensitive Ammunition). This division includes ammunition that contains EIDS. It has been demonstrated through test results that the mass and confinement effects of the ammunition on the probability of initiation of transition from burning to detonation of the EIDS in transport or storage are negligible. Such ammunition, when intentionally initiated, is capable of transferring detonation to another (i.e., propagating).